

# REPAIRMAN

## No. 7 How To Test and Replace Condensers RADIO SERVICING METHODS



## NRI TRAINING PAYS...

Dear Mr. Smith:

I had been going from job to job for fifteen years and was getting nowhere fast. I then decided to study radio. I knew nothing about it before taking your Course, and I was working as a farm hand. After completing the studies and experimental work I took a full time servicing job. Two years later I started my own shop. I now have a \$1000 stock of parts and \$1000 worth of equipment and fixtures. The NRI Course sure started me off right.

C.E.C., Calif.



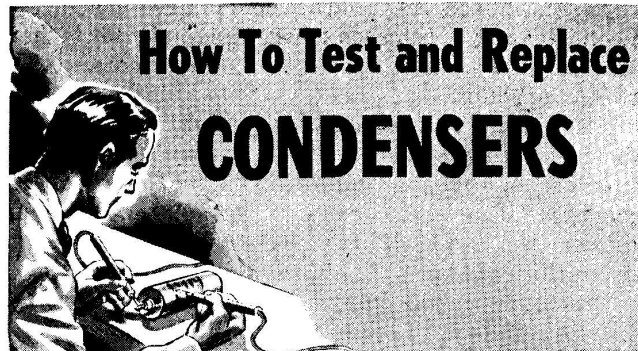
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**W**ITH the possible exception of tubes, condensers cause the greatest amount of trouble in radio receivers. Electrolytic and paper condensers are the worst offenders, but defects also occur in mica, air, and trimmer condensers. This Booklet will show you how condensers of each type become defective, and how they should be tested and replaced.

Your Lessons in Radio Fundamentals have taught you how condensers are made, and what some of their defects may be. We'll review these subjects briefly before we discuss testing and replacement of condensers.

### PAPER CONDENSERS

You know that a paper condenser consists of plates made of sheets of metal foil, separated by a waxed paper dielectric, all rolled up to form a cylinder. Discs of solder or wire spirals to which the leads are attached are pressed into the two ends of the foils, then the condenser is sealed in a hard wax and (usually) encased in a paper container. Now, what can happen to this condenser?

The paper dielectric in one of these condensers may develop a burned spot if excessive voltage is applied or if there is a flaw in the paper. This spot is carbon, which is conductive, so a conducting path (or, as technicians say, a leakage path) is formed between the condenser plates. The effect is the same as if a resistor had been connected between the condenser plates; we say the condenser is leaky, for it will pass d.c. current when a d.c.

voltage is applied. If the burned spot is large enough, the two plates may touch each other. The condenser is then shorted, just as though a wire had been connected between the plates.

Also, if the wax casing cracks, moisture will enter the condenser and will eventually form a leakage path. In addition, leakage may develop on the surface of the condenser if moisture or dust collects on the container between the two leads. This will act like a resistor between the leads.

In some paper condensers, the connecting solder discs or wire spirals are soldered to the foil plate, but in most they are held against the foil only by the wax into which the ends of the condensers are dipped. Often the normal heat of the set will loosen these wax plugs so that the discs pull away from the foil. Effectively, this disconnects the condenser from the circuit, and we say the condenser is *open*.

► Since the condenser opens because one contact pulls away from the foil slightly, a mechanical jar, expansion and contraction caused by temperature changes, or a sudden electrical surge caused by snapping the receiver off and on, may allow the foil and the disc to make contact again and restore the condenser to full operation in the circuit. When this occurs the condenser is said to be *intermittently open*. (Condensers can also leak and short-circuit intermittently, but an open is the most usual intermittent defect.)

► Paper condensers almost never change in capacity. Moreover, they are not used in circuits where such a change in capacity would be important anyway.

**Summary.** Paper condensers may short-circuit, open, open intermittently, or leak; these are the only common defects such condensers have. Now let's learn something about the other condenser types.

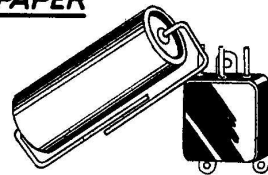
## ELECTROLYTIC CONDENSERS

An electrolytic condenser is a chemical type in which an aluminum plate or foil is one plate, the electrolyte is the other plate, and an aluminum-oxide film is the dielectric. There are three kinds—the dry condenser, in which

## TYPICAL CONDENSERS

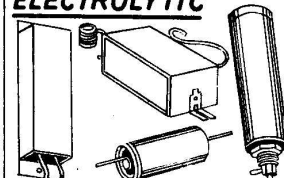
Paper condensers (those using paper as a dielectric) are the kind most commonly used in radio receivers. Usually they are cylindrical and have a wax-impregnated cardboard case. You will occasionally meet the kind shown at the right in the illustration; this is cased in metal.

### PAPER



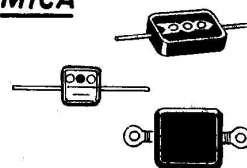
Electrolytic condensers are now universally used as power supply filter condensers. You may meet them in any of the shapes shown in the illustration. The two cylindrical condensers shown have metal cases; the others have cardboard outside cases, but may be enclosed in metal underneath.

### ELECTROLYTIC



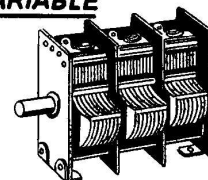
Mica condensers are not widely used in modern broadcast receivers—generally only in the oscillator and second detector circuits. Capacities are usually indicated by a 3 or 6-dot color code. The condensers are encased in either dark brown or light tan bakelite; the latter is a low-loss covering.

### MICA



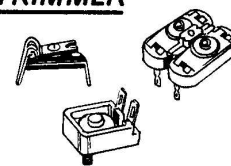
Variable condensers like that shown in the illustration are used to tune most modern receivers. There may be either two or three sections to a tuning condenser used in a superheterodyne; condensers with more than three sections are used in t.r.f. sets.

### VARIABLE



Several trimmer condensers are used in every set, but some are usually hidden within the shields of i.f. transformers so that only their adjusting screws are visible. The three small objects shown at the top of the variable condenser (above) are also trimmer condensers.

### TRIMMER





We have highlighted the condensers that are visible on the top of a typical radio chassis. Four trimmer condensers that are also on top of the chassis are not visible because they are contained within i.f. transformer shields.

the electrolyte is a paste impregnated in a cloth or similar separator; the semi-dry type, in which the electrolyte is a jelly-like substance; and the wet type, in which the electrolyte is an actual liquid.

Electrolytic condensers can short-circuit like a paper condenser if the applied voltage is too high, or if the applied voltage is fed to it with the wrong polarity. (The dielectric film breaks down and conducts current.) This may not damage a *wet* condenser permanently for removal of the overload may permit the dielectric to re-form, but dry or semi-dry condensers are ruined by a breakdown.

► Leakage is quite a problem with electrolytic condensers. They always leak a fairly considerable amount, and, with age (especially when not being used) and with chemical changes in the dielectric, the film gradually deteriorates so that this leakage becomes worse.

With age, also, an electrolytic condenser develops a high power factor, which makes the condenser act as though a high resistance had been placed in series with one of its leads. This is caused by drying out and by chemical changes in the electrolyte that increase the resistance of the electrolyte. This happens sooner in the

dry condensers than in the wet types, because the dry types already have a paste electrolyte, which, as it dries further, increases in resistance. This is the reason that the types sealed in metal cans last longer—they cannot dry out as easily.

► An electrolytic condenser also loses capacity. As the electrolyte evaporates in the wet types, or the paste dries in the dry types, less and less of the electrolyte is in contact with the dielectric, so, effectively, one of the plate areas is reduced.

► It is rather rare to find an electrolytic condenser that is open, for they are more soundly constructed than paper condensers. However, once in a while the electrolyte will corrode the connecting lead where it joins the plate; the condenser will then be open.

## MICA CONDENSERS

A mica condenser consists of alternate layers of metal plates and mica dielectric sheets. Since mica condensers are well made and are generally used in circuits that do not have high d.c. voltages, they seldom become defective. Their only fairly common defect is leakage between the condenser terminals caused by moisture and dust collecting in tiny cracks in the bakelite casing. Once in a while, a crack in the bakelite housing may allow the plates to expand or separate so that the capacity changes, and occasionally a mica condenser opens or shorts.

The capacity of a mica condenser will change somewhat with variations in temperature. This effect would be serious if the condensers were used in circuits where this change would upset tuning, but they seldom are.

## AIR CONDENSERS

When we speak of an air condenser, we mean a condenser having air as the dielectric. Although fixed air condensers have been made for laboratory purposes and for some transmitter uses, in radio receivers air condensers are always variable. A typical example is the variable condenser used to tune most receivers. In a few



of the higher priced receivers, some trimmer condensers are also variable air types.

Modern variable air condensers cause very little trouble. Older types, however, occasionally become defective. For example, the condenser plates may be bent out of shape by some accident, or by warpage of the material in the condenser. If they bend far enough, the stator and rotor plates may touch, which will short-circuit the condenser. Such a short circuit may occur over all the variable range or over only a small portion of it. Even if the plates do not touch, the shift in position will upset the circuit action because of capacity changes.

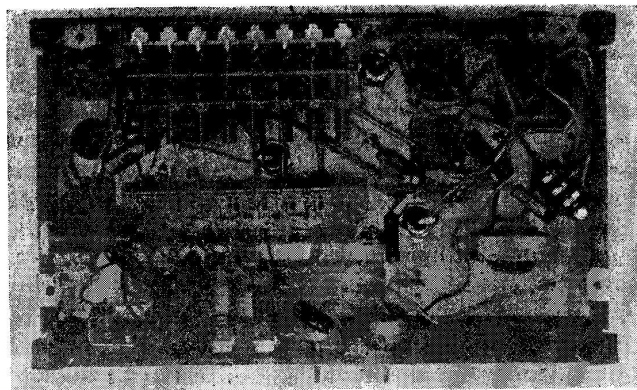
Dust and metal particles between the plates may provide a leakage path or cause a short circuit. In some earlier condensers, a plating was used over the plates of the condensers. This material peeled and flaked, allowing metal particles to short-circuit between the condenser plates.

► In some earlier types, connections were made to a lug that contacted the stator plates of the condenser through screws. Corrosion in the screw threads set up a resistance in series with the condenser. (Late types use a soldered connection that eliminates this.) The rotor section of the gang condenser connects to the frame through the front and rear bearings. Since these bearings do not provide a good electrical contact, often an additional spring contactor is used for each section. Dirt or grease in the bearings or between the spring contactors and the shaft will place resistance between the condenser rotor and the frame of the condenser. ► Thus, air condensers may short-circuit, develop leakage, or develop series resistance. They almost never open, however.

### TRIMMER CONDENSERS

Although a few trimmer condensers are actually air condensers, usually their dielectrics are a combination of air and mica.

Occasionally a trimmer condenser will short-circuit because of a break in the mica, because its plates are



This is a bottom view of the chassis pictured on page 4. Not all of the under-chassis condensers are visible here; others are obscured by other parts.

bent, or because excess solder has been allowed to run between the plates. Some leak because of dust and dirt paths between the plates or cracks in the mica.

The plates of a trimmer condenser are springy, and tend to separate. They are held at the desired spacing by a compression screw. With age, the plates may lose their springiness so that the condenser will not hold its adjustment. This may result in undesirable changes in capacity. A trimmer condenser rarely opens, although once in a great while a plate breaks away from its contacting lug.

► From this description of the various kinds of condensers and their defects, you can see that condenser defects are like those of resistors—short circuits, open circuits, changes in value. In addition, a condenser may develop leakage between its terminals and, particularly in electrolytic and air condensers, can develop a series resistance. Now let's see how you can check for each of these difficulties.

### HOW TO TEST CONDENSERS FOR SHORT CIRCUITS

When a condenser is short-circuited, there is a direct conductive path with little or no resistance between the terminals.

The obvious method of checking condensers for short circuits is to use an ohmmeter. Often you need not even disconnect the condenser to check for a short circuit, because its resistance will be so much lower than that of any shunting path, that you can detect the faulty part easily. However, if you suspect a tuning or trimmer condenser (used in a circuit where there is a coil connected in parallel), or if more than one condenser may be at fault, you must disconnect the suspected part to check it.

The ohmmeter can be used to check any kind of condenser for a short circuit. It indicates a short circuit by reading zero resistance between the condenser terminals.

You may not need any instrument to check an air condenser, for you may be able to see the plates touch. If the receiver tuning condenser is defective (either shorting or out of line), you may find that reception is obtained over a portion of the tuning band but that further turning of the tuning knob results in noises, a scraping sound from between the plates, and (usually) no reception. These are all indications that the tuning condenser is short-circuited, or out of line.

► As extra information—a shorted condenser will frequently pass enough current to burn out a resistor or a coil in an associated circuit. Always check for charred resistors and for continuity through the circuit associated with the shorted condenser.

## HOW TO TEST CONDENSERS FOR LEAKAGE

An ohmmeter will also indicate leakage. However, there are certain things you must remember when you check for leakage.

► Leakage is far more important in some circuits than in others. For example, a by-pass condenser connected

across a low ohmic value resistor can have a leakage resistance value of 50,000 ohms without greatly upsetting the circuit. On the other hand, a coupling condenser used to couple signals from one stage to another may cause distortion if the leakage resistance falls below 10 megohms. These are practical facts that you will study in your Lessons on Radio Fundamentals.

Condensers are never perfect—even the best will leak a certain amount—so you must know just how much leakage can be permitted. A paper or mica condenser freshly made by a reliable manufacturer will have a leakage resistance value\* so high that an ordinary ohmmeter cannot measure it. However, after a fixed condenser has been exposed to moisture and normal atmospheric conditions for a few weeks, its leakage resistance value will become lower. Mica and paper condensers smaller than .1 mfd. are considered satisfactory if their leakage resistances are above 20 megohms. Paper condensers larger than .1 mfd. are considered good if their leakage resistance is above 10 megohms.

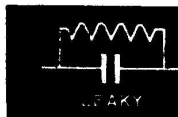
Electrolytic condensers have far lower leakage values. An ordinary electrolytic condenser having a leakage resistance above 1 megohm is very good—it can usually be allowed to go down to about 100,000 ohms before needing replacement, and even this value depends upon the circuit conditions.

**Electrolytic Polarity.** You must know the polarities of the test probes of your ohmmeter before you can check electrolytics for leakage. As you know, your ohmmeter contains a built-in battery to which the probes are connected; one probe is always positive with respect to the other. The positive probe must always be connected to the positive terminal of the electrolytic condenser. Otherwise, the condenser will not function properly, and the leakage resistance your meter indicates will be far lower than the true value. (This is not true of other kinds of condensers; electrolytics are the only condensers that do not work equally well regardless of

\*Don't become confused by *leakage* and *leakage resistance*. The higher the *leakage resistance*, the smaller the *leakage*, because higher resistance values permit less current flow through the undesired path.



A shorted condenser (left) acts as if a direct wire connection had been made across it. A leaky condenser (right) acts as if a resistor had been connected across it.

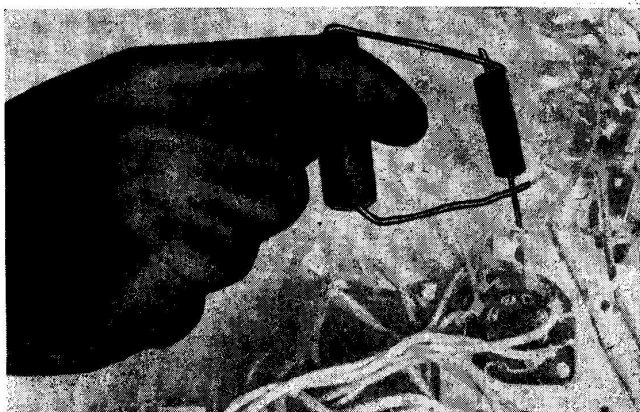


the polarity of the voltage applied to the terminals.)

Ordinarily an ohmmeter is not marked to show which probe is positive, but it's easy enough to find out. Simply touch the probes to the terminals of an electrolytic condenser that you know to be good. The meter needle will swing toward zero resistance at first, then, as the condenser dielectric film "forms" and it charges, the needle will move toward a *higher resistance* value. Wait until the needle stops (or almost stops) and record the resistance indicated. Next, discharge the condenser by touching its leads together or by shorting its terminals with a screwdriver. Then interchange the ohmmeter probes and repeat the measurement. One of the readings you get will indicate considerably higher *resistance* than the other. The meter was properly connected when the higher *resistance* reading was made—at that time the positive probe was connected to the positive terminal of the condenser. Mark the meter to show which is the positive probe, and you are ready to test electrolytics for leakage. (In a multimeter that also measures voltage, the positive *ohmmeter* probe will often be the negative *voltmeter* probe. Therefore, pay no attention to the *voltage* polarity markings when determining the *ohmmeter* polarity.)

► Be sure you disconnect any condenser (paper, mica,

FIG. 1. How to test for an open condenser.



air, or electrolytic) from its circuit before you check it for leakage. You must measure resistance fairly accurately in a leakage check, and leaving the condenser connected to other parts may cause incorrect readings.

### HOW TO CHECK CONDENSERS FOR OPEN CIRCUITS

If you suspect that a paper, electrolytic, or mica condenser is open, there is one very simple test you can make. Just turn on the radio, allow it to warm up, and then hold a condenser you know to be good across the terminals of the condenser which you are testing (Fig. 1). If this test improves the performance of the radio, then the suspected condenser is open.

Sometimes the presence of long leads or of your hand holding the case of the test condenser may cause hum or prevent normal operation. If so, temporarily solder in the new condenser; then you can determine the operation of the receiver more accurately.

► The capacity of the test condenser should be approximately the same as the one across which you connect it, although it need not be exactly the same. If the original condenser is open, any capacity near the original value will improve reception.

Remember to hold paper and mica condensers by their cases, *not by their leads*, to avoid getting a shock. If the leads are insulated, as they are in many electrolytic condensers, you may hold them safely provided your hands remain always on the insulation and never touch the bare wires.

► Checking a condenser not connected in a radio is a somewhat different problem. You must either solder it in a circuit in place of a good condenser, or use your test equipment. If the condenser is fairly high in capacity (above .25 mfd.), your ohmmeter will give you a fair indication as to whether or not it is open. First, make sure the condenser is discharged, by shorting across its terminals with a screwdriver blade. Then touch the ohmmeter probes to the terminals. The ohmmeter battery will charge the condenser (provided the condenser is not open), which will make the needle kick toward

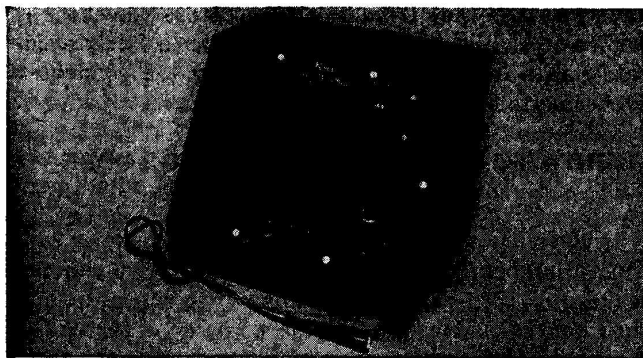


FIG. 2. The NRI Model 111 Professional R-C Tester. This instrument can check condensers for capacity, opens, shorts, leakage, and power factor. It also measures resistance. "Extra" instruments like this are time savers—worth having after a service business is established.

zero. Thus, if the condenser is not open, connecting the ohmmeter to it should produce first a "kick" of the meter needle toward zero resistance; then, as the condenser becomes charged, the needle should move back to a high resistance value almost at once. The amount of "kick" of the needle will depend upon the capacity of the condenser—the larger the condenser the greater the kick. This method works well on fairly high-capacity condensers, but cannot be used with low-capacity (below .05 mfd.) condensers because the kick is too small to be seen.

An instrument known as a capacity analyzer (see Fig. 2) will check condenser capacity accurately and will also check condensers for shorts and leakage.

**Intermittent Opens.** To check for an intermittent open, grasp the suspected condenser and twist or turn the outer case slightly while the set is operating, or move the suspected condenser with an insulated probe or wooden stick. If the condenser is intermittently open, this movement may either create considerable noise or cause the set operation to change radically as the condenser opens and closes.

If the intermittent condition cannot be made to show up by such mechanical jarring or bending, solder a good condenser temporarily across the suspected one. If the

receiver operation clears up when this is done, or the intermittent trouble does not reappear, then the original condenser is probably defective and should be removed from the circuit.

**Important Notice.** *Shunting a condenser across another one is a test that is good ONLY for open condensers, high series resistance (to be discussed next), and, sometimes, for changes in capacity. It does no good whatever to shunt a good condenser across one suspected of leakage or of being short-circuited. The good condenser cannot clear up the leakage or short circuit, so don't try anything except an ohmmeter test for these two troubles.*

## HIGH SERIES RESISTANCE

As you learned earlier, high series resistance usually develops only in electrolytic or air condensers. To detect this condition in air condensers you must be able to interpret the behavior of the receiver as you will learn to do in a later RSM Booklet. However, an electrolytic can readily be tested for high series resistance.

Any series resistance will waste power, thus reducing the effectiveness of the condenser. A logical way to test an electrolytic for high series resistance, then, is to shunt it with another one known to be in good condition. If the receiver operates better, the original condenser is defective.

As you can see, this test doesn't show whether the electrolytic condenser is open or simply has high series resistance, for the result of the test is the same in either case. However, you usually don't care what the defect is; the important thing is that the condenser is defective, and must be replaced.

You can also test for high series resistance with a capacity analyzer that is capable of measuring power factor (the condenser must be disconnected to do so).

**Air Condensers.** You can use a low-range ohmmeter to check for series resistance between the rotor and the condenser frame, and between the stator and its contact. However, poor contacts between the test probes



and the condenser can easily give erroneous readings, so it is better to rely on the operation of the radio to confirm this condition. The series resistance may develop at either the stator connections or the rotor connections, and both can be repaired. If the trouble is due to corrosion on the threads of the screws that make the connections to the stator, it is necessary only to loosen these screws and then to retighten them to break up the corrosion and to provide a good connection again.

If corrosion or dirt occurs at the spring contact that makes the connection to the rotor shaft, pull out the contact, clean it, then bend it to give greater tension and firmer contact. Clean the end bearings on the condenser shaft with carbon tetrachloride or a grease solvent, then regrease them with Grafoline, a conductive lubricant made of vaseline and graphite.

#### HOW TO CHECK CONDENSERS FOR CHANGES IN CAPACITY

Changes in capacity occur most frequently in trimmer condensers and in electrolytics. Any change in capacity of an electrolytic condenser will always be a reduction. You can check for this by connecting another condenser across the suspected one, thereby increasing the capacity in the circuit. If doing so improves performance, the suspected condenser is defective. (Again, this test merely shows that the condenser is defective, without indicating the exact defect.) You can also check the capacity with a capacity analyzer.

► A trimmer condenser may either increase or decrease in capacity if it gets out of adjustment. Usually either condition is detected during alignment of the receiver, which is a subject you will study in later RSM Booklets. Generally the trimmer can be readjusted satisfactorily, but occasionally one must be replaced.

**WARNING.** Do not fall into the bad habit of checking every condenser in a receiver. This is the time-consuming procedure of a radio "mechanic," and is one of the principal reasons why such men are severely limited in the number of sets they can service in a day. Future Lessons and Booklets will teach you how to deduce from

the operation of a set, and by a system of localization, whether a condenser is probably defective and which condenser it is likely to be. *Never check a condenser unless you have a good reason to suspect that it is defective.*

#### HOW TO REPLACE CONDENSERS

Defective condensers can usually be replaced from a stock of standard types. You will rarely have to order an exact duplicate replacement part except for air condensers, trimmer condensers, special electrolytic filters, and certain special mica condensers. Replacements for the condensers that most commonly break down—paper and electrolytic types—can readily be obtained. Here are a few good rules to remember.

**Paper Condensers.** A paper condenser has two ratings of importance—its capacity and its voltage rating. Physical size doesn't matter as long as a replacement fits into the space allotted.

Usually the original capacity is marked right on the condenser. Generally, this marking is a decimal—such as .1, .05, or .001—followed by the abbreviation "mfd." Sometimes the abbreviation is not given. Similarly, the working voltage is usually marked on the condenser case. Common working voltages are 200, 400, or 600 volts.

If the defective condenser is not marked to show the capacity and working voltage, you can find them from the manufacturer's information or from Table 1, which shows satisfactory capacity values for various paper and mica condenser uses. (You'll learn about these uses in your Lessons.)

TABLE 1

USE	CAPACITY CAN BE ANY VALUE BETWEEN
R. F. AND I. F. BY-PASSING	.01 to .1 MFD.
A. F. BY-PASSING	.25 to 1 MFD.
GRID LEAK CONDENSER	.00025 to .0005 MFD.
A. F. COUPLING	.002 to .05 MFD.
BUFFER (FOR VIBRATORS)	.001 to .05 MFD.

► It is best to use 600-volt condensers even when you replace a 200- or a 400-volt unit. The extra cost for the higher working voltage is negligible, and you are sure that the condenser will stand any voltage normally present in a receiver. (There is one exception to this rule—a buffer condenser must be rated at 1200 to 2000 volts.)

**Electrolytic Condensers.** In addition to capacity and working voltage, electrolytic condensers have a third important rating—the surge voltage. The surge voltage rating is important because it is the maximum peak voltage that may be applied to the condenser, and, for electrolytics, it is only a little higher than the working voltage. When the set is turned on, the set voltage will first rise to near the surge value, then come down to the working value as the tubes warm up. You must be sure that the condenser surge voltage rating will not be exceeded during the first few moments of operation; otherwise, the condenser will break down.

Table 2 gives the ranges of values of electrolytic condensers that are used in various radio circuits. (You will study the circuits in your lessons.) Usually there is some clue to the size of the electrolytic that should be used to make a replacement. However, if there is none, simply use a condenser with a capacity near the bottom of the range for the particular circuit. If the result is not satisfactory, try condensers with higher capacities until normal operation is produced. An electrolytic can almost always be satisfactorily replaced by one of higher capacity.

The types of electrolytics (dry, semi-dry, and wet) are usually interchangeable if of the proper ratings.

However, you should check the surge voltage carefully before using a dry in place of a wet condenser. Some circuits have high surge voltages that do no permanent harm to a wet, but which would ruin a dry type. In such cases, a replacement wet type is the best to use.

► Electrolytic condensers may be physically different, particularly in their methods of mounting (see Fig. 3). It is not necessary to use an exact duplicate type as long as the replacement can be mounted in the available space.

When you replace the “can” type shown at A in Fig. 3, remember that the can is often the negative terminal connection of the condenser. The can may ground to the chassis, or it may be insulated from the chassis by insulating paper. In replacing the latter types, be sure you replace the insulation (or use a condenser that does not ground to the chassis) so that the circuit will not be upset.

FIG. 3. You may find any of these methods used to mount an electrolytic. In the relatively new mounting method shown in C, the condenser is plugged into the socket, then the three outside lugs are twisted to lock the condenser in place.

#### METHODS OF MOUNTING ELECTROLYTICS

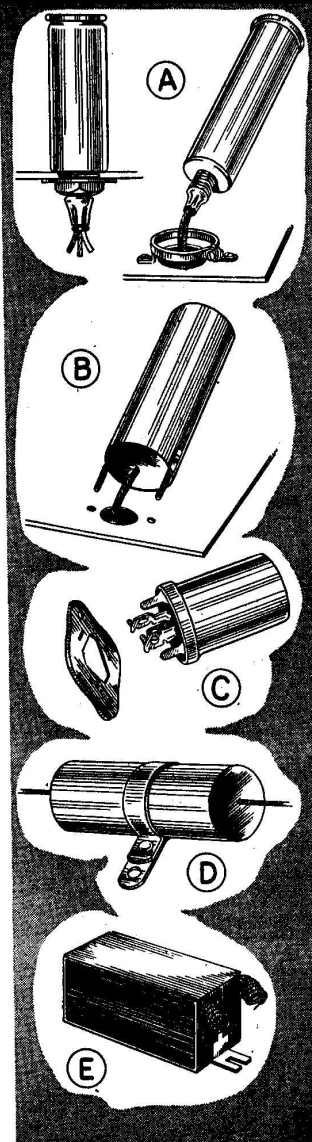


TABLE 2

CIRCUIT	CAPACITY (MFD)	D.C. WORKING VOLTAGE (VOLTS)
OUTPUT FILTER A.C. SET	8 to 60	450
INPUT FILTER A.C. SET	8 to 40	450
OUTPUT FILTER A.C.-D.C. SET	16 to 60	150
INPUT FILTER A.C.-D.C. SET	8 to 30	150
A.F.-R.F. FILTER	8 to 30	350 to 450
A.F. CATHODE BY-PASS	5 to 50	25 to 50

Where two wire leads are brought out of a *single* section electrolytic, the can is merely a housing, and the leads go to the condenser. Although there is no universally used code, the positive lead is usually colored red and the negative lead is black.

► Electrolytic condensers are frequently combined into "blocks" or units of two or more condensers. Frequently only one of the condensers in a block will be defective. This one unit may be replaced by a single-section unit, but usually it is best to replace the entire block, as other units are likely to go bad soon.

Identifying leads and connections on a multi-section block may not be easy if the color code is not marked on the unit. You will learn farther along in your Course how to trace connections to find the proper connecting polarities.

Let's suppose you have to replace a 2-section block (the most common type). The manufacturer may have brought out all the leads as in Fig. 4A, or he may have connected leads together inside the block as in Figs. 4B

and 4C. In Fig. 4B, the positive leads are connected together — this unit is intended for use in a radio where both these leads go to the same point. This condenser is described as having a *common positive* lead. Fig. 4C shows a unit with a *common negative* lead. The blocks shown in Figs. 4B and 4C are not interchangeable, but the one shown in Fig. 4A can be used to replace either of these just by connecting the proper leads together.

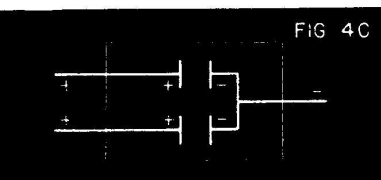
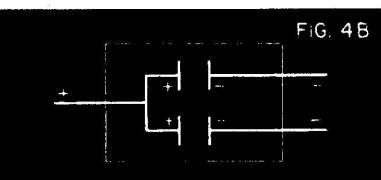
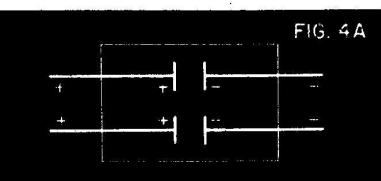
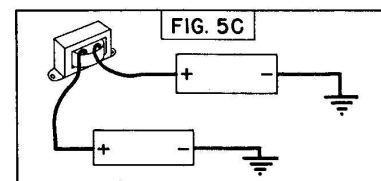
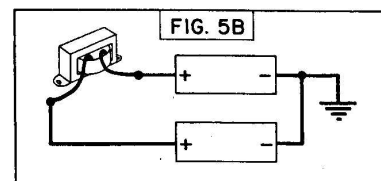
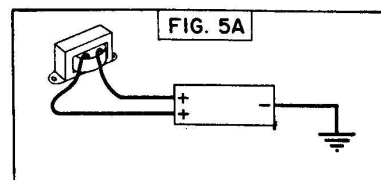
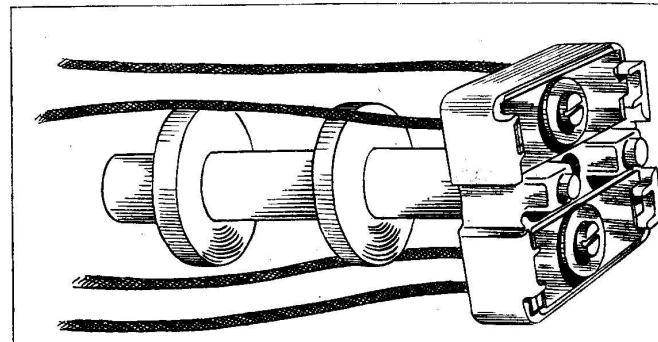
Also, two single-unit condensers could be used as the replacement. Fig. 5 shows examples of this. The original unit is shown at A.

Sometimes it is convenient to cut the leads off the original condenser, close to its case, and use these leads as the connecting wires on the replacements (Fig. 5B). The replacements may also be mounted as in Fig. 5C if there is room and the connections are easy to make.

**Air Condensers.** These condensers rarely need replacement. If one does, obtain an exact duplicate—one intended to operate in that particular make and model receiver. This can be ordered from the manufacturer or distributor of the set or from some of the large supply houses. If an exact duplicate is not available, send the defective gang to a supply house to be matched as closely as possible.

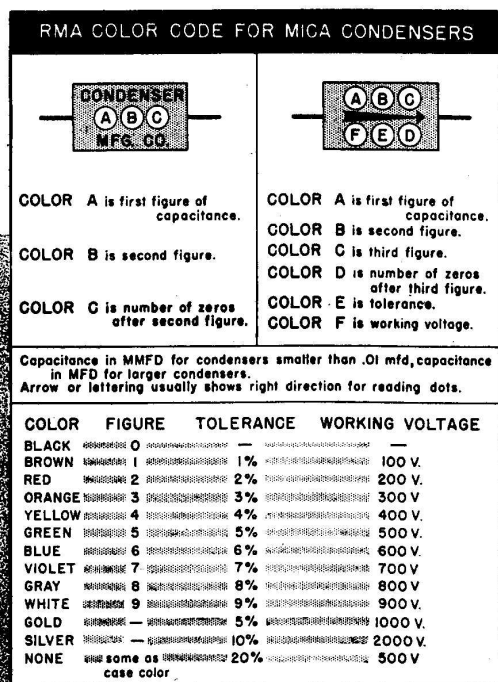
**Trimmer Condensers.** When trimmer condensers become defective, it is usually necessary to replace them with exact duplicates. If the trimmer is part of a coil assembly, as in Fig. 6, it is easier to replace the entire assembly, as a replacement assembly is much easier to obtain than are replacement trimmers.

FIG. 6. Here's what a typical i.f. coil assembly looks like when the shield can is removed.



**Mica Condensers.** Mica condensers should be replaced by units having similar capacities. The capacity value may or may not be stamped on the condenser. There is a color code used with mica condensers, shown in Fig. 7, but this is not followed by all set manufacturers. For this reason it is usually best to determine the proper size from your knowledge of the circuit action, or by consulting the manufacturer's information.

As you will notice, there are several methods of marking these condensers. In the style using six colors, the tolerance of the condenser value and the working voltage are also given (the latter is usually 500 volts for mica condensers used in receivers).



**FIG. 7**

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